What is claimed is:

1. An interferometry system comprising:

an interferometer which during operation directs a measurement beam along a measurement path contacting a measurement object and combines each of at least two portions of the measurement beam with a corresponding reference beam to form at least two overlapping pairs of exit beams, the interferometer comprising a beam-steering assembly having a beam-steering element and a positioning system to orient the beam-steering element, the beam-steering element positioned to direct the measurement beam to the measurement object, the measurement beam contacting the beam-steering element;

a control circuit which during operation causes the positioning system to reorient the beam-steering element in response to a change in angular orientation of the measurement object; ~~and~~

an angle measurement system which during operation calculates the change in angular orientation of the measurement object based on at least one of interferometric signals derived from the overlapping pairs of exit beams and the reorientation of the beam-steering element.

2. The interferometry system of claim 1, wherein during operation the angle measurement system calculates the change in angular orientation of the measurement object based on the reorientation of the beam-steering element.

3. The interferometry system of claim 1, wherein during operation the angle measurement system calculates the change in angular orientation of the measurement object

based on the interferometric signals derived from the overlapping pairs of exit beams.

4. The interferometry system of claim 1, wherein during operation the angle measurement system calculates the change in angular orientation of the measurement object along two dimensions.

5. The interferometry system of claim 1, wherein during operation the angle measurement system further calculates changes in distance to the measurement object based on at least one of the interferometric signals derived from the overlapping pairs of exit beams.

6. The interferometry system of claim 1, wherein during operation the control circuit generates a servo signal based on the interferometric signals derived from the overlapping pairs of exit beams and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

7. The interferometry system of claim 6, wherein during operation the control circuit causes the positioning system to reorient the beam-steering element along two dimensions based on the servo signal.

8. The system of claim 1, wherein the control circuit comprises a detector having spatially resolved detector elements operative to measure the position and/or direction

of at least a portion of the overlapping pairs of exit beams, and wherein during operation the control signal generates a servo signal based on the measured position and/or direction and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

9. The system of claim 8, wherein the detector is operative to measure the difference in position and/or direction between the exit beams of at least one of the overlapping pairs of exit beams.

10. The system of claim 8, wherein the detector is operative to measure the position and/or direction of the measurement beam component of at least one of the overlapping pairs of exit beams relative to a reference position and/or direction.

11. The system of claim 1, wherein during operation the interferometer directs the at least two portions of the measurement beam to contact the beam-steering element before combining each of them with the corresponding reference beam.

12. The system of claim 1, wherein during operation the control circuit causes the measurement beam to contact the measurement object at substantially normal incidence over a range of angular orientations of the measurement object.

13. An interferometry system comprising:

an interferometer which during operation directs a measurement beam along a measurement path contacting a measurement object, separates the measurement beam into *m* portions, and recombines at least a part of one of the portions with each of the remaining *m-1* portions to form *m-1* overlapping pairs of exit beams, the interferometer comprising a beam-steering assembly having a beam-steering element and a positioning system to orient the beam-steering element, the beam-steering element positioned to direct the measurement beam to the measurement object and receive the *m* separated portions, the measurement beam and each of the *m* separated portions contacting the beam-steering element;

a control circuit which during operation causes the positioning system to reorient the beam-steering element in response to a change in angular orientation of the measurement object; and

an angle measurement system which during operation calculates the change in angular orientation of the measurement object based on at least one of interferometric signals derived from the *m-1* overlapping pairs of exit beams and the reorientation of the beam-steering element.

14. The interferometry system of claim 13, wherein m is one of 2 and 3.

15. The interferometry system of claim 13, wherein during operation the angle measurement system calculates the

change in angular orientation of the measurement object along two dimensions.

16. The interferometry system of claim 13, wherein during operation the control circuit generates a servo signal based on the interferometric signals derived from the *m-1* overlapping pairs of exit beams and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

17. The system of claim 13, wherein the control circuit comprises a detector having spatially resolved detector elements operative to measure the position and/or direction of at least a portion of the *m-1* overlapping pairs of exit beams, and wherein during operation the control signal generates a servo signal based on the measured position and/or direction and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

18. The system of claim 13, wherein during operation the control circuit causes the measurement beam to contact the measurement object at substantially normal incidence over a range of angular orientations of the measurement object.

19. An interferometry system comprising:

an interferometer which during operation directs two measurement beams along corresponding measurement paths contacting a measurement object and combines the measurement beam to form an overlapping pair of exit beams, the interferometer comprising a beam-steering assembly having a beam-steering element and a positioning system to orient the beam-steering element, the beam-steering element positioned to direct the two measurement beams to the measurement object, the two measurement beams contacting the beam-steering element;

a control circuit which during operation causes the positioning system to reorient the beam-steering element in response to a change in angular orientation of the measurement object; and

an angle measurement system which during operation calculates the change in angular orientation of the measurement object based on at least one of an interferometric signal derived from the overlapping pair of exit beams and the reorientation of the beam-steering element.

20. The interferometry system of claim 19, wherein during operation the control circuit generates a servo signal based on the interferometric signal derived from the overlapping pair of exit beams and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

21. The system of claim 19, wherein the control circuit comprises a detector having spatially resolved detector elements operative to measure the position and/or direction of at least a portion of the overlapping pair of exit beams, and wherein during operation the control signal generates a servo signal based on the measured position and/or direction and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

22. The system of claim 19, wherein during operation the control circuit causes the measurement beam to contact the measurement object at substantially normal incidence over a range of angular orientations of the measurement object.

23. The system of claim 19, wherein the interferometer directs the two measurement beams to contact the measurement object at substantially the same location.

24. An interferometry system comprising:

an interferometer which during operation receives an input beam, splits the input beam into a measurement beam and *m* reference beams, where *m* is an integer greater than 1, directs the measurement beam along a measurement path contacting a measurement object, and combines each of *m* portions of the measurement beam with a corresponding one of the *m* reference beams to form *m* overlapping pairs of exit beams,

a beam-steering assembly having a beam-steering element and a positioning system to orient the beam-steering element, the beam-steering element positioned to direct the input beam and the *m* overlapping pairs of exit beams, the input beam and the *m* overlapping pairs of exit beams contacting the beam-steering element;

a control circuit which during operation causes the positioning system to reorient the beam-steering element in response to a change in angular orientation of the measurement object; and

an angle measurement system which during operation calculates the change in angular orientation of the measurement object based on at least one of interferometric signals derived from the *m* overlapping pairs of exit beams and the reorientation of the beam-steering element.

25. The interferometry system of claim 24, wherein during operation the angle measurement system further calculates changes in distance to the measurement object based on at least one of the interferometric signals derived from the *m* overlapping pairs of exit beams.

26. The interferometry system of claim 24, wherein during operation the control circuit generates a servo signal based on the interferometric signals derived from the overlapping pairs of exit beams and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

27. The system of claim 24, wherein the control circuit comprises a detector having spatially resolved detector elements operative to measure the position and/or direction of at least a portion of the overlapping pairs of exit beams, and wherein during operation the control signal generates a servo signal based on the measured position and/or direction and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

28. The system of claim 24, wherein during operation the control circuit causes the measurement beam to contact the measurement object at substantially normal incidence over a range of angular orientations of the measurement object.

29. An interferometry system comprising:

an interferometer which during operation receives an input beam, splits the input beam into two measurement beams, directs the measurement beams along respective measurement paths contacting the measurement object, and combines the measurement beams to form an overlapping pair of exit beams,

a beam-steering assembly having a beam-steering element and a positioning system to orient the beam-steering element, the beam-steering element positioned to direct the input beam and the overlapping pair of exit beams, the input beam and the overlapping pair of exit beams contacting the beam-steering element;

a control circuit which during operation causes the positioning system to reorient the beam-steering element in response to a change in angular orientation of the measurement object; and

an angle measurement system which during operation calculates the change in angular orientation of the measurement object based on at least one of an interferometric signal derived from the overlapping pair of exit beams and the reorientation of the beam-steering element.

30. The interferometry system of claim 29, wherein during operation the control circuit generates a servo signal based on the interferometric signal derived from the overlapping pair of exit beams and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

31. The system of claim 29, wherein the control circuit comprises a detector having spatially resolved detector elements operative to measure the position and/or direction of at least a portion of the overlapping pair of exit beams, and wherein during operation the control signal generates a servo signal based on the measured position and/or direction and causes the positioning system to reorient the beam-steering element in response to the change in angular orientation of the measurement object based on the servo signal.

32. The system of claim 29, wherein during operation the control circuit causes the measurement beam to contact the measurement object at substantially normal incidence over a range of angular orientations of the measurement object.

33. An interferometry system comprising:

an interferometer which during operation directs a measurement beam along a measurement path contacting a measurement object, separates the measurement beam into first and second portions, directs the first and second portions along separate paths, and subsequently recombines the first and second portions with each other to form at least one overlapping pair of exit beams, the interferometer comprising a beam-steering assembly having a beam-steering element and a positioning system to orient the beam-steering element, the beam-steering element positioned to direct the measurement beam to the measurement object and subsequently receive the measurement beam from the measurement object, the measurement beam thereby twice contacting the beam-steering element, after which the interferometer separates the measurement beam into the first and second portions;

a control circuit which during operation causes the positioning system to reorient the beam-steering element in response to a change in angular orientation of the measurement object based on at least one interferometric signal derived from the at least one overlapping pair of exit beams; and

an angle measurement system which during operation calculates the change in angular orientation of the

measurement object based on the reorientation of the beam-steering element.

34. The interferometry system of claim 33, wherein the interferometer recombines the first and second portions into two overlapping pairs of exit beams, and the at least one interferometric signal is at least two interferometric signals derived from the two overlapping pairs of exit beams.

35. The interferometry system of claim 34, wherein the control circuit comprises two detection channels which during operation measure the at least two interferometric signals, one of the detection channels comprising a quarter wave plate oriented to cause the two interferometric signals to be in quadrature with one another.

36. The interferometry system of claim 33, wherein during operation the interferometer further separates the measurement beam into third and fourth portions after the measurement beam twice contacts the beam-steering element, directs the third and fourth portions along separate paths, and recombines the third and fourth portions to form a second at least one pair of overlapping exit beams, and wherein during operation the control circuit causes the positioning system to reorient the beam-steering element along two dimensions based on the at least one interferometric signal and a second at least one interferometric signal derived from the second at least pair of overlapping exit beams.

37. The interferometry system of claim 33, wherein during operation the angle measurement system calculates the change in angular orientation of the measurement object along two dimensions.

38. The interferometry system of claim 33, wherein the during operation the interferometer further separates the measurement beam into an additional portion after the measurement beam twice contacts the beam-steering element and combines the additional portion with a reference beam to form an additional pair of overlapping exit beams, and wherein the interferometry system further comprises a distance measurement system which during operation measures changes in distance to the measurement object based on an interferometric signal derived from the additional pair of overlapping exit beams.

39. The interferometry system of claim 1, wherein the interferometer further comprises a plurality of reflective surfaces oriented to direct the measurement beam, the portions of the measurement beam, a progenitor beam for the reference beams, and the reference beams, and for initial linear polarizations and propagation directions for the measurement beam and the progenitor beam, the plurality of reflective surfaces is oriented to preserve a linear polarization for the measurement beam, the portions of the measurement beam, a progenitor beam for the reference beams, and the reference beams upon their successive reflections.

40. The interferometry system of claim 13, wherein the interferometer further comprises a plurality of reflective surfaces oriented to direct the measurement beam and the portions of the measurement beam, and for an initial linear polarization and propagation direction for the measurement beam, the plurality of reflective surfaces is oriented to preserve a linear polarization for the measurement beam and the portions of the measurement beam upon their successive reflections.

41. The interferometry system of claim 19, wherein the interferometer further comprises a plurality of reflective surfaces oriented to direct the measurement beams, and for an initial linear polarization and propagation direction for a progenitor beam for the measurement beams, the plurality of reflective surfaces is oriented to preserve a linear polarization for the measurement beams upon their successive reflections.

42. The interferometry system of claim 24, wherein the interferometer further comprises a plurality of reflective surfaces oriented to direct the measurement beam and the reference beams, and for an initial linear polarization and propagation direction for the input beam, the plurality of reflective surfaces is oriented to preserve a linear polarization for the measurement beam and the reference beams upon their successive reflections.

43. The interferometry system of claim 29, wherein the interferometer further comprises a plurality of reflective

surfaces oriented to direct the measurement beams, and for an initial linear polarization and propagation direction for the input beam, the plurality of reflective surfaces is oriented to preserve a linear polarization for the measurement beams upon their successive reflections.

44. The interferometry system of claim 33, wherein the interferometer further comprises a plurality of reflective surfaces oriented to direct the measurement beam and the portions of the measurement beam, and for an initial linear polarization and propagation direction for the measurement beam, the plurality of reflective surfaces is oriented to preserve a linear polarization for the measurement beam and the portions of the measurement beam upon their successive reflections.

45. An interferometry method comprising:

directing a measurement beam along a measurement path contacting a measurement object;

combining at least a portion of the measurement beam with another beam to form an overlapping pair of exit beams;

using an electronic control system to redirect the measurement beam in response to a change in the angular orientation of the measurement object based on a servo signal derived from at least a portion of the overlapping pair of exit beams; and

calculating the change in angular orientation based on at least one of an interferometric signal derived from the overlapping pair of exit beams and the redirection of the measurement object.

46. The interferometry method of claim 45 wherein using the electronic control system comprises redirecting the measurement beam to contact the measurement object at substantially normal incidence over a range of angular orientations of the measurement object.

47. A lithography system for fabricating integrated circuits comprising:

first and second components, the first and second components being movable relative to one another; and

the interferometry system of claim 1 secured to the second component, wherein the measurement object is a mirror rigidly secured to the first component and during operation the interferometry system measures the position of the first component relative to the second component.

48. The lithography system of claim 47, wherein the second component is a movable stage which during operation supports a wafer.

49. The lithography system of claim 47, wherein during operation the beam-steering element causes the measurement beam to contact the mirror at substantially normal incidence over a range of angular orientations of the measurement object.

50. A lithography method comprising:

positioning a first component of a lithography system relative to a second component of a lithography system to expose a wafer to spatially patterned radiation; and

measuring the position of the first component relative to the second component using the method of claim 45 wherein the first component includes the measurement object.

51. A beam writing system for use in fabricating a lithography mask, the system comprising:

a source providing a write beam to pattern a substrate;

a stage supporting the substrate;

a beam directing assembly for delivering the write beam to the substrate;

a positioning system for positioning the stage and beam directing assembly relative one another; and

the inteferometry system of claim 1 for measuring the position of the stage relative to the beam directing assembly.

52. A beam writing method for use in fabricating a lithography mask, the method comprising:

directing a write beam to a substrate to pattern the susbtrate;

positioning the substrate relative to the write beam; and

measuring the position of the substrate relative to the write beam using the interferometry method of claim 45.

53. A method for correcting an angle θ_l indicative of a relative angular orientation of a measurement object for

the effects of dispersion caused by gas along a measurement path contacting the measurement object, wherein the angle θ_l is measured interferometrically at a wavelength λ_l, the method comprising:

interferometrically measuring the angular orientation at a first wavelength λ_q to give a first angle θ_q indicative of the angular orientation;

interferometrically measuring the angular orientation at a second wavelength λ_u not equal to the first wavelength λ_q to give a second angle θ_u indicative of the angular orientation;

correcting the angle θ_l by an additive factor $\Delta\theta_l = -\Gamma(\theta_q - \theta_u)$, where $\Gamma = (n_l - 1)/(n_q - n_u)$ is the reciprocal dispersive power of the gas and n_l, n_q, and n_u are the indices of refraction of the gas at wavelengths λ_l, λ_q, and λ_u, respectively.

54. The method of claim 53, wherein the angle θ_l is the first measured angle θ_q and $\lambda_l = \lambda_q$.

55. The method of claim 53, wherein the angle θ_l is the second measured angle θ_u and $\lambda_l = \lambda_u$.

56. The method of claim 53, wherein the angle θ_l is different from either the first measured angle θ_q or the second measured angle θ_u, $\lambda_l \neq \lambda_q$, and $\lambda_l \neq \lambda_u$.

57. An interferometry system comprising:

an interferometer which during operation directs a reference beam along a reference path and a measurement beam along a measurement path contacting a measurement object and combines the reference and measurement beams to produce overlapping exit reference and measurement beams, the overlapping exit reference and measurement beams indicative of changes in a relative optical path length between the reference and measurement paths, the interferometer comprising a beam steering assembly having a beam steering element and a positioning system to orient the beam steering element, the beam steering element having at least two faces positioned to direct the measurement beam after it contacts the measurement object, the measurement beam contacting the measurement object and subsequently contacting each of the two faces during propagation within the interferometer; and

a control circuit which during operation causes the positioning system to reorient the beam steering element in response to changes in at least one of angular orientation and position of the measurement object.

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